Arizona Department of Agriculture
Arizona Iceberg Lettuce Research Council
Final Report for 2003-2004

Evaluation of potential management tools for Fusarium wilt and Sclerotinia drop on lettuce

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Abstract

Fusarium wilt. The effect of soil flooding, soil solarization and select fungicides on subsequent severity of Fusarium wilt on lettuce was studied. Soil naturally infested with *Fusarium oxysporum* f.sp. *lactucae* was placed in 5-gallon buckets that were buried in a field so that the upper lip of each bucket was level with the soil surface. For the soil flooding trial, the soil within each bucket was maintained in a flooded state for 15, 30, 45 or 60 days. For the soil solarization trial, the soil in each microplot was thoroughly irrigated, then covered with a clear plastic normally used for soil solarization for 15, 30, 45 or 60 days. For the 60-day duration of the trial, the mean soil temperature at a depth of 5 cm for flooded, untreated and solarized soil was 88, 98 and 109°F, respectively. Compared to plants grown in untreated soil, the severity of Fusarium wilt symptoms was significantly less on roots and foliage and fresh weight of plants was significantly greater for lettuce grown in flooded or solarized soil for 15 to 60 days. In separate trials, three different fungicides, Medallion (fludioxonil), Pristine (boscalid+pyraclostrobin), and Topsin M (thiophanate-methyl) were applied to lettuce plantings immediately after seeding and two additional times at 3-week intervals. None of the tested fungicides reduced the incidence or severity of Fusarium wilt compared to untreated plants.

Sclerotinia drop. Sclerotinia drop on lettuce is caused by two soil-borne fungi, *Sclerotinia minor* and *S. sclerotiorum*. Some registered products as well as new chemistries in development were compared for their ability to suppress Sclerotinia drop on lettuce during the winter vegetable growing season in 2003-2004. Sclerotia of each pathogen were incorporated into plots after lettuce was thinned and just before the first application of test compounds. In plots infested with either *Sclerotinia minor* or *S. sclerotiorum*, all materials tested at an appropriate rate significantly reduced disease. In plots infested with *S. minor*, the best treatments included Endura, Fluazinam, and Contans alternated with Endura. For plots containing *S. sclerotiorum*, the best treatments included Fluazinam, Contans, Switch, Endura, and Contans alternated with Endura. Two of the products tested, Contans and Serenade, are biological control materials.

Introduction

Fusarium wilt was first detected in Yuma County lettuce fields in 2001 and has been confirmed in 26 different sites by the end of the 2003-04 production season. Sclerotinia drop also can be found in any given year in some Arizona lettuce fields. The pathogens that cause these diseases in combination with favorable environmental conditions can lead to severe and widespread levels of disease with resultant significant crop losses. Successful management of these fungal pathogens and the diseases that they cause is essential for realization of improved quality and maximum yield potential of lettuce in Arizona.

Development of disease management strategies for Fusarium wilt will be a formidable challenge. Historically, management of Fusarium wilt on crops other than lettuce, such as tomatoes and melons, has been achieved by planting cultivars resistant to the fungal pathogen. Another report presents the results of field trials evaluating resistance of lettuce cultivars to Fusarium wilt. Additional disease control measures, such as extended soil flooding and soil solarization, have shown promise in managing Fusarium wilt in other cropping systems. Additionally, fungicides such as thiophanate-methyl and fludioxonil have activity against *Fusarium* species and may be a useful component of a Fusarium disease management package. These disease management approaches need to be evaluated for lettuce under our environmental conditions in western Arizona.

Current management strategies for Sclerotinia drop are heavily reliant upon chemical disease control products. Due to increasing environmental concerns as well as potential development of tolerance to fungicides by fungal pathogens, there is no guarantee that materials currently in use will be available in the future. New and more effective, as well as environmentally desirable methods of disease management are needed, not only for conventional production but organic systems as well. New disease management products currently are being developed by several different agrochemical companies. The novel modes of action of these compounds offer the possibility of controlling the above mentioned pathogens in new and exciting ways.

The objectives of these studies were to evaluate the effect of soil flooding, soil solarization and select fungicides on subsequent severity of Fusarium wilt on lettuce and to evaluate new emerging products for management of Sclerotinia drop of lettuce.

Materials and Methods

Fusarium wilt. Fusarium wilt of lettuce is caused by the fungal pathogen *Fusarium oxysporum* f. sp. *lactucae*. The pathogen can survive in soil for many years in the form of resistant chlamydospores. The effect of soil flooding and soil solarization on survival of the pathogen in soil was evaluated during the summer of 2003. Naturally infested soil was placed in containers (5-gallon buckets) that were buried in a field at The University of Arizona Yuma Mesa Agricultural Center so that the upper lip of each bucket was level with the soil surface. Each bucket was considered a replicate microplot. In the flooding trial, the soil in the microplots was maintained in a saturated state (flooded) for 15, 30, 45 or 60 days. For the solarization trial, the soil in the microplot containers was thoroughly irrigated, then covered with a clear plastic normally used for soil solarization for15, 30, 45 or 60 days. The flooding and solarization treatments were initiated July 22 and terminated September 22, 2003. The control (untreated soil) in this study was soil in microplots that was not irrigated, flooded or solarized. Temperature of flooded, solarized and untreated soil was recorded. On November 25, soil from each microplot was placed in a series of 1-pint capacity pots. A 14-day-old lettuce seedling (cultivar Lighthouse) was transplanted into each pot and maintained in the greenhouse for approximately 45 days. At the conclusion of the trial, the fresh weight of each lettuce plant was determined. Foliar and root ratings of Fusarium wilt severity were also performed on each plant using the following rating scale: Foliar symptom rating: 0 = no apparent disease, 1 = slight to moderate stunting, 2 = severe stunting and yellowing, 3 = dead plant; Root symptom rating: 0 = no discoloration of root cortex, 1 = slight to moderate yellowing, 2 = slight to moderate red streaking, 3 = necrotic cortex tissue.

For the fungicide evaluation study, plots of lettuce (cultivar Lighthouse) were established in a randomized complete block design, with five replicate plots per treatment, within a field naturally infested with the lettuce Fusarium wilt pathogen. The first application of fungicides, including Medallion (fludioxonil at 0.2 lb/acre), Pristine (boscalid+pyraclostrobin at 0.6 lb/acre), and Topsin M (thiophanate-methyl at 1.05 lb/acre) were applied to lettuce beds over the top of each seed line immediately after seeding and before the onset of the sprinkler irrigation to germinate the seed. Fungicides also were applied to lettuce plants and the surrounding bed surface 3- and 6-weeks after the initial treatment. Control plots received no fungicide treatment. This trial was conducted three times in lettuce plots planted September 3, October 21 and December 18, 2003. Final incidence and severity of Fusarium wilt was determined at crop maturity.

Sclerotinia drop. This study was conducted at The University of Arizona Yuma Valley Agricultural Center. The soil was a silty clay loam (7-56-37 sand-silt-clay, pH 7.2, O.M. 0.7%). Sclerotia of *Sclerotinia minor* were produced in 0.25 pint glass flasks containing 15-20 sterilized 0.5 in. cubes of potato by seeding the potato tissue with mycelia of the fungus. After incubation for 4-6 wk at 68°F, mature sclerotia were separated from residual potato tissue by washing the contents of each flask in running tap water within a soil sieve. Sclerotia were air-dried at room temperature, then stored at 75°F until needed. Inoculum of *Sclerotinia sclerotiorum* was produced in 2 qt glass containers by seeding moist sterilized barley seeds with mycelia of the pathogen. After an 8-wk incubation at 68°F, abundant sclerotia were formed. The contents of each container were then removed, spread onto a clean surface and air-dried. The resultant mixture of sclerotia and infested barley seed was used as inoculum. Lettuce 'Winterhaven' was seeded November 6, 2003 on double rows 12 in. apart on beds with 40 in. between bed centers, then germinated with sprinkler irrigation from November 7 to 10. Furrow irrigation was performed Nov 25, Dec 19, Jan 16, Feb 6 and Feb 27. Treatments were replicated five times in a randomized complete block design. Each replicate plot was 25 ft long and contained two rows of lettuce. Plants were thinned Dec 7 at the 3-4 leaf stage to a 12 in. spacing. Sclerotia were applied to plots on Dec 19. For plots infested with *Sclerotinia minor*, 0.13 oz (3.6 grams) of sclerotia were distributed evenly on the surface of each 25-ft-long plot between the rows of lettuce and incorporated into the top 1.0 in. of soil. For plots infested with *Sclerotinia sclerotiorum*, 0.5 pint of a dried mixture of sclerotia and infested barley grain was broadcast evenly over the surface of each 25-ft-long lettuce plot, again between the rows of lettuce on each bed, and incorporated into the top 1.0 inch of soil. Treatment beds were separated by single nontreated beds. Unless noted otherwise in the data tables, treatments were applied with a tractor-mounted boom sprayer with nozzles spaced 12 in. apart that delivered 50 gal/acre at 100 psi. Test materials were applied to the surface of the bed and plants at the times described in the data tables. Mean soil temperature (°F) at the 10 cm depth was as follows: Dec, 52; Jan, 52; Feb, 57; Mar, 68. The severity of disease was determined at plant maturity (March 15) by recording the number of dead plants in each plot. As a point of reference, the original stand of lettuce was thinned to approximately 50 plants per plot.

Results and Discussion

Fusarium wilt. For the 60-day duration of the soil flooding and solarization trial (July 22 to September 22, 2003), the mean soil temperature at a depth of 5 cm for flooded, untreated and solarized soil was 88, 98 and 109°F, respectively. Lettuce plants grown in soil flooded or solarized from 15 to 60 days had milder symptoms of Fusarium wilt compared to those grown in untreated soil (Figs. 1 and 2). The foliar symptoms of the disease tended to be less severe as the flooding or solarization period increased from 15 to 60 days; however, this trend was not evident with respect to root symptoms. The fresh weight of plants grown for approximately 45 days in flooded or solarized soil was over twice the weight recorded for plants grown in untreated soil (Fig. 3). This initial study suggests that a period of soil flooding or solarization may reduce the severity of Fusarium wilt in a subsequent planting of lettuce. This trial will be repeated in 2004 to confirm these preliminary results. For the fungicide studies, application of boscalid+pyraclostrobin, fludioxonil or thiophanate-methyl to lettuce beds immediately after seeding and two additional times after plant emergence did not reduce the severity of Fusarium wilt compared to untreated plants.

Sclerotinia drop. In plots infested either with *Sclerotinia minor* or *S. sclerotiorum*, all materials tested at an appropriate rate significantly reduced disease (Table 1). In plots infested with *S. minor*, the best treatments included Endura, Fluazinam, and Contans alternated with Endura. For plots containing *S. sclerotiorum*, the best treatments included Fluazinam, Contans, Switch, Endura, and Contans alternated with Endura. Two of the products tested, Contans and Serenade, are biological control materials. Contans is a strain of the fungus *Coniothyrium minitans* and Serenade is a strain of the bacterium *Bacillus subtilis*. For a valid comparison of products for control of Sclerotinia drop of lettuce, it is important to compare the results obtained from more than one field study. The reader is urged to review previous studies in addition to this report to get a true picture of the relative efficacy of compounds for control of Sclerotinia drop.

Figure 1.

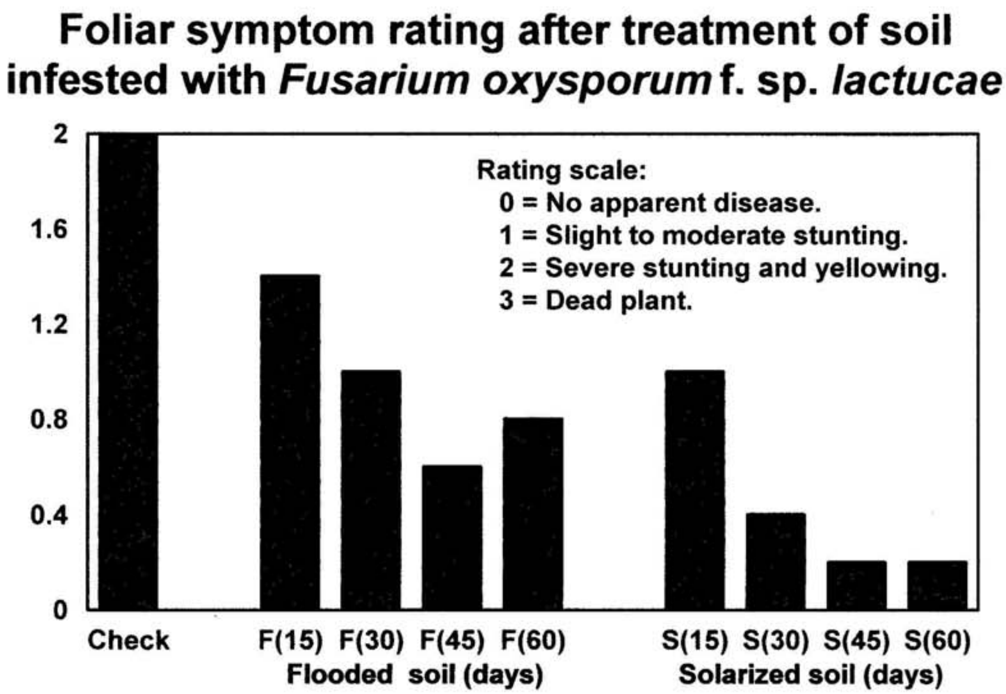

Figure 2.

Root symptom rating after treatment of soil infested with *Fusarium oxysporum* f. sp. *lactucae*

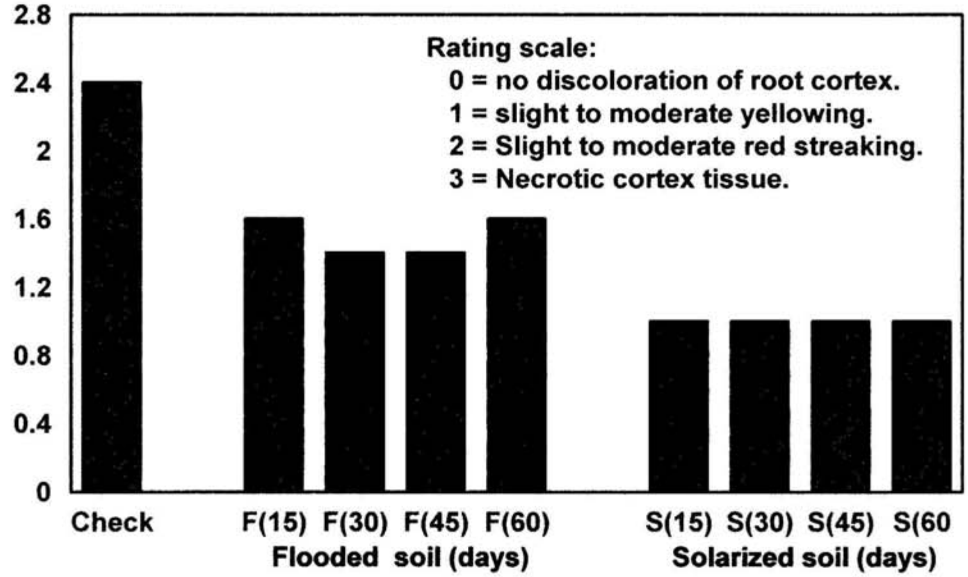

Figure 3.

Plant fresh weight (g) after treatment of soil infested with *Fusarium oxysporum* f. sp. *lactucae*

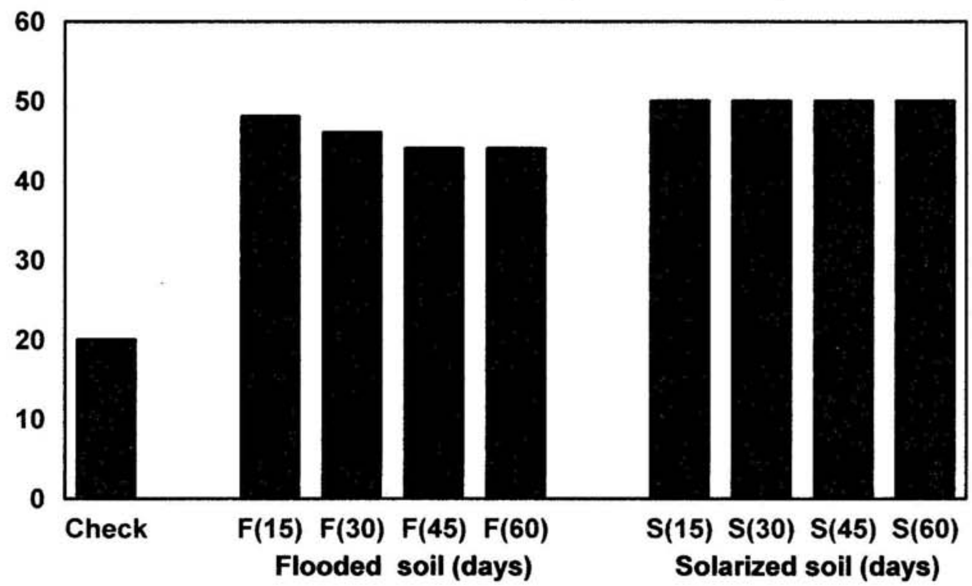

Table 1.

2003-2004 Sclerotinia Drop of Lettuce Fungicide Trial, Yuma Valley Agricultural Center

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Treatment	Rate (lb a.i/acre)	Treatment dates [1]	Diseased plants per 25 ft plot [2]	
			S. minor	*S. sclerotiorum*
Endura (BAS 510) 70WG	0.48	1,2	16.6	43.6
Fluazinam (500 g/l)	1.5	1	16.8	29.8
Endura (BAS 510) 70WG	0.25	1,2	18.0	35.8
Fluazinam (500 g/l)	1.0	1	19.8	41.4
Contans (water incorporation) [3]	4.0 lb product	1		
alternated with Endura 70WG	0.45	2	21.4	37.8
Serenade AS + Sonata AS				
(water incorporation) [3]	2.0 qt + 1.0 qt product	1,2	23.4	50.2
Fluazinam (500 g/l)	0.5	1	24.2	46.2
Contans (water incorporation) [3]	4.0 lb product	1,2	25.8	32.0
Rovral 4F	1.0	1,2	25.8	28.0
Switch 62.5 WG	0.43	1,2	26.0	33.8
Botran 5F	1.87	1,2	26.4	44.6
Switch 62.5 WG	0.43	2,3	26.6	37.0
Serenade AS (water incorporation) [3]	4.0 qt product	1,2	28.2	46.8
Koni (water incorporation) [3]	4.0 lb product	1,2	28.6	43.6
Switch 62.5 WG	0.55	1,2	28.8	35.4
Switch 62.5 WG	0.55	2,3	29.0	41.2
Sonata AS (water incorporation) [3]	2.0 qt product	1,2	29.4	51.8
Serenade AS + Contans				
(water incorporation) [3]	4.0 qt + 4.0 lb prod.	1,2	29.6	43.8
Unntreated control	--------	--------	39.0	51.0
LSD			**4.6** [4]	**2.7** [4]

1. Treatments were applied to soil on 1) Dec 20, 2003; 2) Jan 8, 2004; 3) Jan 22.

2. Disease assessment was performed at crop maturity on March 15, 2004. Each 25 ft. plot contained approximately 50 heads. All diseased plants were dead or dying.

3. Product applied to bed surface between lettuce rows in 1.0 gal of water per plot. An additional 1.0 gal of water was applied to further incorporate the product into the soil. All other treatments were applied with a tractor-mounted boom sprayer that delivered 50 gal/acre at 100 psi.

4. Least Significant Statistical Difference at $P = 0.05$.